Steam ESA 236-2_Ace Ethanol_Stanley, WI
Public Report - Final

Company	Ace Ethanol	**ESA Dates**	November 12th to 14th
Plant	Stanley, Wisconsin	**ESA Type**	Steam
Product	Ethanol & Co-products	**ESA Specialist**	Tom Tucker, P.E.

Brief Narrative Summary Report for the Energy Savings Assessment:

Introduction:
On behalf of the Department of Energy, Tom Tucker of Kinergetics LLC conducted a steam system ESA at the Ace Ethanol facility in Stanley, Wisconsin from November 12th to 14th, 2007. The ESA and training activities were provided through the United States Department of Energy-Save Energy Now initiative, which was established to help the largest natural gas users in the United States identify ways to reduce energy use.

The estimated annual energy cost savings for the projects evaluated is provided in **Table 1** above.

Steam
Steam is provided by two 1,500-hp fire tube boilers operating approximately 82-percent efficiency on average based on combustion testing and steam system modeling. The facility generates steam at 108-psig to meet process and HVAC steam requirements. Flash steam is recovered and used to help meet process heating demands.

<u>Other Items to Consider</u>
A number of issues can be addressed that are not related specifically as projects in the sections that follow. These include:

Steam Trap Maintenance and Repair
An effective trap program is important and should be followed to minimize wasted steam, prevent parasitic (artificial) steam loads and prevent water hammer. Water hammer can not only damage piping and equipment but also poses a potential risk to worker safety. There was a noted amount of water hammer, particularly in the boiler room due to drip leg traps that were valved shut. This is causing backup of condensate into the main steam header, which is picked up by steam causing the water hammer.

There was not a significant amount of venting noted so the energy cost savings from trap repair is questionable. Nevertheless, trap maintenance is importance and will over time minimize water hammer related maintenance cost. Until the trap failure rate is under control it is recommended that inspection and repair/replacement be performed twice per year. The frequency may be decreased as the number of identified failures stabilizes.

It is also recommended that traps be verified to match their intended use. The following can be used as guidelines for trap selection:

a. Do not use inverted bucket traps on pressures less than 30-psig. This includes unit heaters. When possible, avoid their use all together since they can be problematic with respect to keeping “prime.”
b. Use Float and Thermostatic traps (F&T) for process applications.
c. Use thermostatic traps for drip legs. Avoid thermodynamic (disc) traps as they tend to fail closed causing backup of condensate and potentially damaging water hammer. Also, the operation of these traps is susceptible to changes in ambient conditions.

Use of internal staff for trap repair and replacement can be economical if they are properly trained for inspection and installation and have time to do the assessment in a timely manner. If the repair and replacement activities taken an extended period of time over what an outsourced group would take, the venting losses could far outweigh any savings that would have been gained from use of internal labor.

Evaporator NCG Lines
It is necessary to remove noncondensable gases from the evaporator to maintain proper vacuum. However, because steam is removed as well, care should be taken not to over vent. Since the valves appear to the fully open this should be checked.

Variable Speed Drive on the Boiler FD Fan
Pressure measurements across the boiler #2 FD fan indicates a pressure drop of approximately 6.2-inwc across the damper. The 125-hp FD fan motor is operating into its service factor and may be a candidate for a variable speed drive. This is recommended for consideration.

Lighting
The facility uses high intensity discharge lighting that is a candidate for replacement with 6-lamp T8 fixtures with a high ballast factor ballast. The replacement can usually be made on a one-to-one basis and will reduce lighting cost by approximately 50-percent. Based on operating hours and the electricity rate the simple return will be on the order of 3 years. This is recommended for further consideration.

Objective of ESA:
The primary objective of the ESA was to identify steam cost reduction opportunities and to have the primary ESA lead become comfortable with the use of the DOE steam tools.

Focus of Assessment:
SSAT was applied to model cost reduction opportunities identified during walk-throughs and group discussions, with particular attention given to the steam venting issues. Additionally, assistance was provided to address trap sizing and piping design issues that may be contributing to valve flange gasket failures.

Approach for ESA:
The ESA started with an introduction and a brief Power Point presentation introducing the different steam tools. The Steam System Scoping Tool (SSST) was completed during the assessment. The facility scored 54.7-percent. Scores above 75-percent are considered very good and scores below 55-percent indicate opportunity for improvement.

General Observations of Potential Opportunities:
Below are brief descriptions of each opportunity evaluated. Each opportunity has been rated based on the following definitions:

1. Near term opportunities: Include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
2. Medium term opportunities: Require purchase of additional equipment and/or changes in the system such as addition of recuperative air pre-heaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
3. Long term opportunities: Require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

1. Steam Demand Reduction - Recover Heat from the RTO Exhaust for Beer Column Feed Preheating (medium term)
The exhaust from the RTO is hot and contains a significant amount of water vapor, making it suitable for heat recovery with a condensing economizer. Condensing economizers or condensing heat recovery (CHR) systems are designed to allow exhaust to be cooled to a much lower temperature (90°F to 130°F) than is possible with “standard” heat recovery methods because CHR systems can handle the acidic condensate that is formed as the exhaust drops below dew-point. As a result, more energy is recovered and cost savings increase due to the heat released when the water vapor in the exhaust condenses. There is about 1-lb water vapor formed for each 10,000-Btu of gas burned.

Because CHR systems work best when the entering water is cool, it is important to have a relatively cool single pass flow or in the case of recirculated flow, enough heat must be removed to send cool water back to the CHR unit from the point of use. Due to the higher water content of the RTO exhaust, return water temperatures can be hotter than would normally be required for efficient CHR operation.

Technical Feasibility
Based on discussions with a vendor during the assessment, CHR appears to be favorable for use in preheating of the beer column feed prior to the feed heater. The vendor wished to place the beer directly into the CHR unit. While this will keep overall cost down and improve annual cost savings to a degree, Kinergetics does *not* recommend this approach because of the near certainty that cleaning will be an issue as with any other heat exchanger used for process fluids in ethanol faculties. The alternative approach is to incorporate a "runaround loop" were hot water at 205°F is recirculated from the CHR unit through a plate and frame exchanger, with beer column feed on the opposite side. This will require additional expense but for maintenance and reliability it is strongly recommended.

Assuming that vendor information on the performance of the CHR unit is correct, preliminary analysis of heat recovery system performance indicates that the beer column feed temperature can be increased from 156°F to approximately 189°F. This value appears to be conservative based on review of different plates exchangers but is used for cost savings estimates.

Because use of a runaround loop is suggested, a pump will also be required and the energy for pumping must be accounted for. Assuming a pump differential of 100-psig, the pump power requirement will be approximately 55-hp.

Estimated Energy Cost Savings
The estimated annual energy cost savings for preheating the beer column feed is $933,000 and the cost for pump operation is approximately $17,000. Thus, the estimated annual cost savings is the difference or $916,000. The cost for the CHX unit is estimated at $1.4-million. Total installed cost will likely ranged from $2-million to $2.7-million once stainless piping, the plate and frame heat exchanger, recirculation pump and installation costs are considered. The simple return will range from 2.2 to 3 years.

This project appears very favorable and is recommended for further consideration.

Notes:
1. It may be feasible to include the DG dryer in the same loop as the beer column beer. This has the advantage of a potentially significant increase in savings with minimal additional cost since the CHR unit will already be present.
2. A detailed engineering analysis will be necessary to finalize cost and energy cost savings.
3. All assumptions must be verified.
4. Heat exchangers, CHR systems and piping all cause pressure drops that must be handled by the protein dryer burner system and inlet fans. Capacities and operating conditions should be checked for compatibility with any changes made.

2. Steam Demand Reduction – Improve Interchanger Effectiveness
The interchanger is a plate and frame heat exchanger that provides cooling of hot corn mash prior to the fermenters and preheating of the beer before it reaches the beer column feed heater. Because the interchanger affects both heating and cooling duties, it is desirable to have the most effective heat exchange possible without sacrificing reliability.
The performance of heat exchangers can be compared by their "effectiveness." Effectiveness is determined based on the fluid flows and fluid properties and the design of the heat exchanger itself. A detailed review of the process data available suggests inconsistencies in the interchanger energy balances due to errors in assumptions on flows, temperatures or both. These will need validation before a definitive analysis can be made.

However, to provide some level of the potential cost benefit, the "effectiveness" was estimated at 77.5-percent based on the original exchanger design data and then recalculated to be 76-percent by changing the mash and beer flows and using the temperature of 110°F to the mash cooler as a limit. The temperature to the mash cooler was chosen as a limit since it will be the limiting factor in exchanger performance. This places the temperature to the beer column at about 165°F which can be checked.

Based on discussions with one heat exchanger supplier, the lower temperature feasible to the mash cooler is approximately 107°F. Using this value as a lower limit, the steam demand reduction potential is approximately 1,075-pph which equates to an annual energy cost reduction of approximately $103,000 per year. In addition, there will also be a reduction in cooling load, cooling tower water evaporation and pumping electricity use but theses benefits are likely not large in comparison to the thermal benefits.

A plate and frame heat exchanger sized for the entire interchanger duty will likely cost between $175,000 and $225,000 installed. It may be possible to use the existing exchanger to reduce the size and cost of this opportunity and this is recommended for consideration. If the assumptions are correct, the expected simple return will range from 1.7 to 2.2 years.

This opportunity appears to be worthwhile and is recommended for further consideration. However, see notes below.

Notes:

1. All temperature and flow data needs to be confirmed to develop better estimates of potential. This is critical since additional recovery becomes economically impractical when the mash temperature to the cooler gets below 106°F.
2. Exchangers should be cleaned as necessary to maintain optimum performance. Three day intervals are normally recommended but this can vary depending on actual operating conditions. Temperatures and pressure drops should be closely watched to determine when cleaning is necessary. Every 1°F the beer column feed temperature drops from fouled interchangers will cost approximately $26,000 per year.

<u>3. Improve Boiler Efficiency – Consider Oxygen Trim Control and a Burner Upgrade (medium term)</u>

Oxygen trim control is an automatic means to control boiler efficiency and is controlled by continuous monitoring of the oxygen concentration in the boiler exhaust. Feedback is then provided to a computer that adjusts the combustion air-to-fuel ratio with servo drives. This technology is most suited to boilers that experience a wide variation of load. Based on a evaluation of boiler efficiency, it may be possible to increase efficiency by approximately 1-percent with better control of excess air with oxygen trim control. It may be that a new burner is also required to obtain the efficiency gain.

A more detailed analysis is required to determine the actual benefit possible but assuming a 1-percent gain is realized over both boilers, the annual cost savings will be on the order of $85,000. The boilers require a larger burner and the installed cost will likely range from $175,000 to $250,000 to retrofit both boilers. This will provide a simple return ranging from 2 to 3 years.
This opportunity appears to be worthwhile and is recommended for further consideration.

Note:

1. The boiler includes flue gas recirculation (FGR) and the performance of this system needs to be considered against any changes made to the burner and controls.

<u>4. Increase Boiler Efficiency: Recover Sensible Heat from Boiler Blowdown (medium term)</u>

The current boiler configuration does not appear to include blow heat recovery, which can be used to preheat boiler makeup water. A preliminary analysis indicates that a single shell and tube unit should be feasible to provide an estimated annual cost savings of approximately $36,000. The simple return is expected to be approximately 1 year.

This project is recommended for further consideration and implementation as appropriate.

Notes:

1. Shell and tube heat exchangers are recommended over plate and frame units in blow down service for ease of cleaning.
2. Flash heat recovery can be used with the shell and tube unit to increase savings, but the increase based on the preliminary analysis indicates that the incremental gain is not worth the additional cost. Nevertheless, use of flash flask recovery should be retained as an option if needed.

<u>5. Consider Replacement of the Vacuum Eductors on the Evaporators with Liquid Ring Pumps (medium term)</u>

The evaporators used to concentrate thin stillage operate under vacuum. The vacuum system includes a liquid eductor that requires 850-gpm of 100-psig “motive” water to help maintain vacuum. Eductors are not as efficient as liquid ring pumps (LRVP) for vacuum service and when vacuum pressures are not too low there is an opportunity to replace them.

This appears to be a good opportunity based on evaporator operation but a more detailed evaluation, including verification of data is needed to estimate cost savings. However, based on other ethanol facilities of the same size, the annual cost savings for both evaporators is on the order of $60,000 (total) with a simple return of 1.2 to 2 years.

This opportunity appears to be worthwhile and is recommended for further consideration.

<u>6. Improve Steam Distribution System Insulation (near term)</u>
With natural gas prices as high as $9.00/MMBtu, any bare steam pipe should be insulated. The cost for the insulation assuming that there is a reasonable amount of insulation to be installed is approximately $15 to $20 per lineal foot.

Valves and regulators such as in the boiler room, heat exchangers and flash tanks are also areas worthy of insulation. These can be insulated with "removable" insulation to allow maintenance when necessary. Removable insulation is more expensive than standard pipe insulation (per foot) but is still cost effective.

While a detailed insulation survey was not performed, based on observation there are a number of steam valves, bare pipe and pipe with damaged insulation that should be replaced. For example, there were 22-valves ranging from 2 to 8-inches that can be fitted with removable insulation. Many of these were located in boiler room and evaporator areas. Considering the bare steam and hot water piping also noted, the estimated annual cost savings will likely be in the range of $8,000 to with the simple return on the order of one year.

A few suppliers for removable insulation are provided below for convenience but no endorsement of any particular supplier is implied.

- B&B insulation: 920.733.6086
- Advance Thermal Corporation: 630.595.5150
- Coverflex Manufacturing: 713.378.0966

This opportunity is recommended for further consideration.

Notes:

1. A detailed insulation survey is recommended to more completely quantify the potential cost savings.

<u>7. Reduce Steam Demand – Reduce Steam and Condensate Leaks (near term)</u>
Generally, steam and condensate leaks are minimal but a few opportunities were noted. Examples are the union near the steam trap on sieve superheater B and the condensate to the floor on VS-710 in the boiler house. Repair of leaks should always be a priority when they are found since they are costly. A leak of only 50-pph will cost approximately $5,000 per year. This leak rate is equivalent to a boiler makeup water rate of only 1/10-gpm.

Leak repair will usually pay for itself in less than one year. For this reason leak repair is recommended as necessary.

<u>8. Process Heating – Natural Gas Reduction for Distillers Grain Dryer (medium term)</u>
The DG dryer is a candidate for inlet air preheating using the same CHR system as discussed as long as it is properly sized. Based on work at other facilities the annual cost savings is likely be over $150,000. Given that the most expensive components will already be installed with **Option 1**, the cost to install inlet air preheating will be incremental and the return in the range of one year.

This option is recommended for consideration with **Option 1**.

Notes:

1. Fan capacity will also need to be checked to determine whether or not it can take the pressure drop caused by the fin-tube exchanger that will be used to transfer heat to the inlet dryer air.

Management Support and Comments:
Generally, the initial feedback on the ESA was favorable. Overall, facility staff was engaged, helpful and interested in applying the models to help screen cost reduction opportunities.

DOE Contact at Plant/Company: (who DOE would contact for follow-up regarding progress in implementing ESA results…)

Plant Contact: Joe Fischer

Company Contact: Joe Fischer